train generator **46** are preferably adjusted to co-allign the 16 pulses in approximately in single direction but not exactly. We prefer that the mirrors be slightly misaligned so that the, pulses are spread over an angle of about 1 milliradian. We discuss the reason for this below.

HIGH POWER AMPLIFIER

The output of the pulse train generator **46** is directed to high power amplifier **48**. Amplifier **48** is a XeCI excimer laser used in a double pass configuration. In our prototype device we use a high power XeCI excimer laser (similar to Model 4000 available from Lambda Physik and several other commercially available high power XeCI lasers) modified to operate as an amplifier. The pulse train is injected into the amplifier through a positive lens **50** such that the beam has a small diameter at an edge of the amplifier input aperture. Lens **50** focal length (about 50 cm) is chosen such that the beam expands as it propagates along the first pass, to fully fill the aperture of amplifier **48** at the end of the first pass. The beam is then reflected for a second pass by a concave mirror **51** having a radius of curvature of about 3 meters chosen to result in a collimated beam for the second pass. The resulting output is a pulse laser beam consisting of bunches of pulses, the bunches spaced at 14 millisecond intervals with 16 pulses (spaced at 2 ns intervals) in each bunch. This is an average of 70 pulse bunches per second and 1120 pulses per second with an energy per pulse of 30×10^{-3} Joules and a pulse duration of about 50 ps for a peak power per pulse of about 0.6×10^{9} Watts and an average power of the beam of 34 Watts.

TARGET CHAMBER

The beam from high power amplifier **50** is directed to target chamber **52** where the high power pulses are focused by a high quality, aberation-corrected lens **53** such as a 10 cm focal length aspheric lens or a triplet lens system to produce a high intensity beam on metal tape target **54** which preferably is a soft copper tape. (Nickel or iron alloy tape could also be used). The thickness of the tape is preferably chosen to be no greater than 25 microns, so that each pulse blows a hole in the tape so that most of the debris is blown through to the back of the tape. The beam is focused to a 10 micron diameter spot size, but because the mirrors of the pulse train generator are slightly out of alignment, the spots are spread over a 200 micron diameter area. At the cross sectional area of 8×10^{-7} cm^2, corresponding to the 10 micron spot, each 0.6×10^{9} Watt pulse will provide an intensity of 7×10^{14} Watts/cm^2. At these intensity levels each pulse in the train generates a plasma at the target consisting of highly ionized atoms of copper from the copper tape target. The plasma temperature and density are sufficiently high that significant quantities of x-rays characteristic of copper plasma are generated in a wavelength range from 8 to 16 A. Typically 5 to 10 percent of the laser pulse energy is converted to X-ray emission in this range. In our prototype device we achieve a conversion efficiency of about 5 percent using copper and an 11 percent efficiency using iron targets. This gives us an average X-ray power of about 3.5 Watts for iron and about 1.8 Watts for copper.

LITHOGRAPHY

With 8–16 A wavelength X-rays we can print very small circuits in the range of 0.1 microns to 0.25 microns. The 3.5 Watt power output would allow a production rate of about 10 wafers per hour. By increasing the pulse rates of the two excimer lasers to 300 Hertz by using a commercially available 300 Hertz lasers, we could increase the average X-ray power to 15 watts and increase our production rate to about 40 wafers per hour. While the above description contains many specificities, the reader should not construe these as limitations on the scope of the invention, but merely as exemplifications of preferred embodiments thereof. Those skilled in the art will envision many other possible variations that are within its scope. For example, the there are many other sources for the commercially available lasers which have been listed. Alternatively, standard laser text books contain instructions for fabrication of these lasers. This invention combines an XeCI excimer amplifier and an XeCI excimer preamplifier and a picosecond seed pulse tailored for a XeCI excimer device. The seed laser could be supplied by a small excimer laser with a Pockels cell configured to slice a pulse of less than 100 picoseconds (preferably about 50 ps) from the excimer laser output. This pulse would be directed to the preamplifier. In this case the amplifier fire signal pulse would be generated from the electrical pulse used to switch the Pockel cell. The small excimer laser could be created within a portion of the preamplifier cavity. The seed laser could also be generated with a mode-locked, q-switched Cr:LISAF laser. This is a tunable laser that can be tuned to the wavelength of the XeCI excimer laser by third harmonic generation. The mode-locking technique generates the pulses of 50 ps duration, while q-switching provides energy enhancement. It should be noted that if background amplified spontaneous emission from the preamplifier interferes with the operation of the amplifier in generating clean, well modulated trains of pico second pulses, a saturable absorber dye may be inserted at the focus of lens **50**, as shown in FIG. **2**. A suitable dye for the XeCI excimer laser wavelength would be BBQ (4,4 d1(2-butyloctoxy)-p-quater-phenyl), dissolved in cyclohexane (as discussed in Journal of Applied Physics, vol 65, page 428) at a concentration such that the intensity of the picosecond pulse bleaches the dye while the intensity of the background does not. Persons skilled in the art will recognize that two or more of amplifier laser **48** shown in FIG.**2** could be used in parallel to provide a higher power configuration. Thus, average laser power outputs in the range of 500 Watts to 1,000 Watts can be provided with currently available laser equipment.

Another embodiment assembled and tested by Applicants places the multiplexer **46** shown in FIG. **2** between the first and second passes through the preamplifier **44** following spatial filter **46**. This works best for preamplifiers having relatively long gain pulses (greater than 30 ns). The system shown in FIG. **2** works better for preamplifiers with short gain pulses (shorter than 10 ns).

Accordingly, the reader is requested to determine the scope of the invention by the appended claims and their legal equivalents, and not by the examples which have been given.

We claim:

1. An improved high average power, high brightness laser system comprising:

A) a seed laser means for producing a seed laser beam consisting of a series of pulses each pulse having a duration of less than 1 ns with a pulse rate in excess of 100 pulses per second,

B) an XeCI excimer preamplifier arranged to amplify said seed laser beam to produce a preamplified pulse laser beam defining preamplified pulse rate,

C) an XeCI excimer laser amplifier arranged to amplify said preamplified pulse laser beam to produce an ampli-